



Cabinet Office

UK Government Progress to Build Resilience to Severe Space Weather

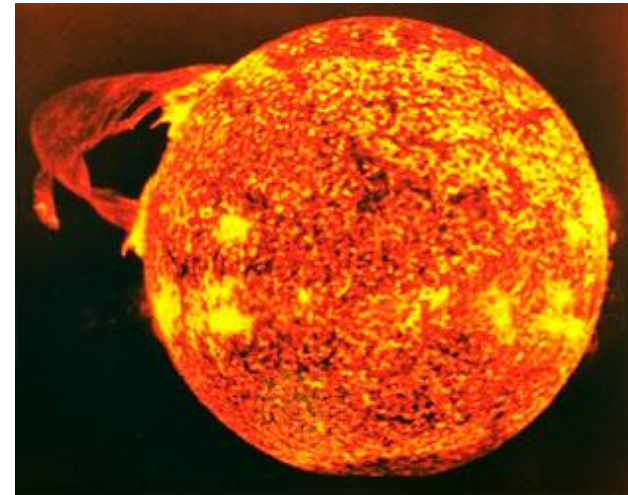
Boulder, April 2014

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- 1. Recap – UK Government approach**
- 2. Progress made**
- 3. UK forecasting capability**
- 4. Next steps**





Assessing the space weather risk

- UK discussions started early 2010
 - Space Environment Impacts Expert Group (SEIEG) formed November 2010
 - Emphasis on (peer reviewed) scientific evidence
 - Reasonable worst case scenario agreed
 - Included as a risk in the National Risk Assessment: 2011 and National Risk Register in 2012

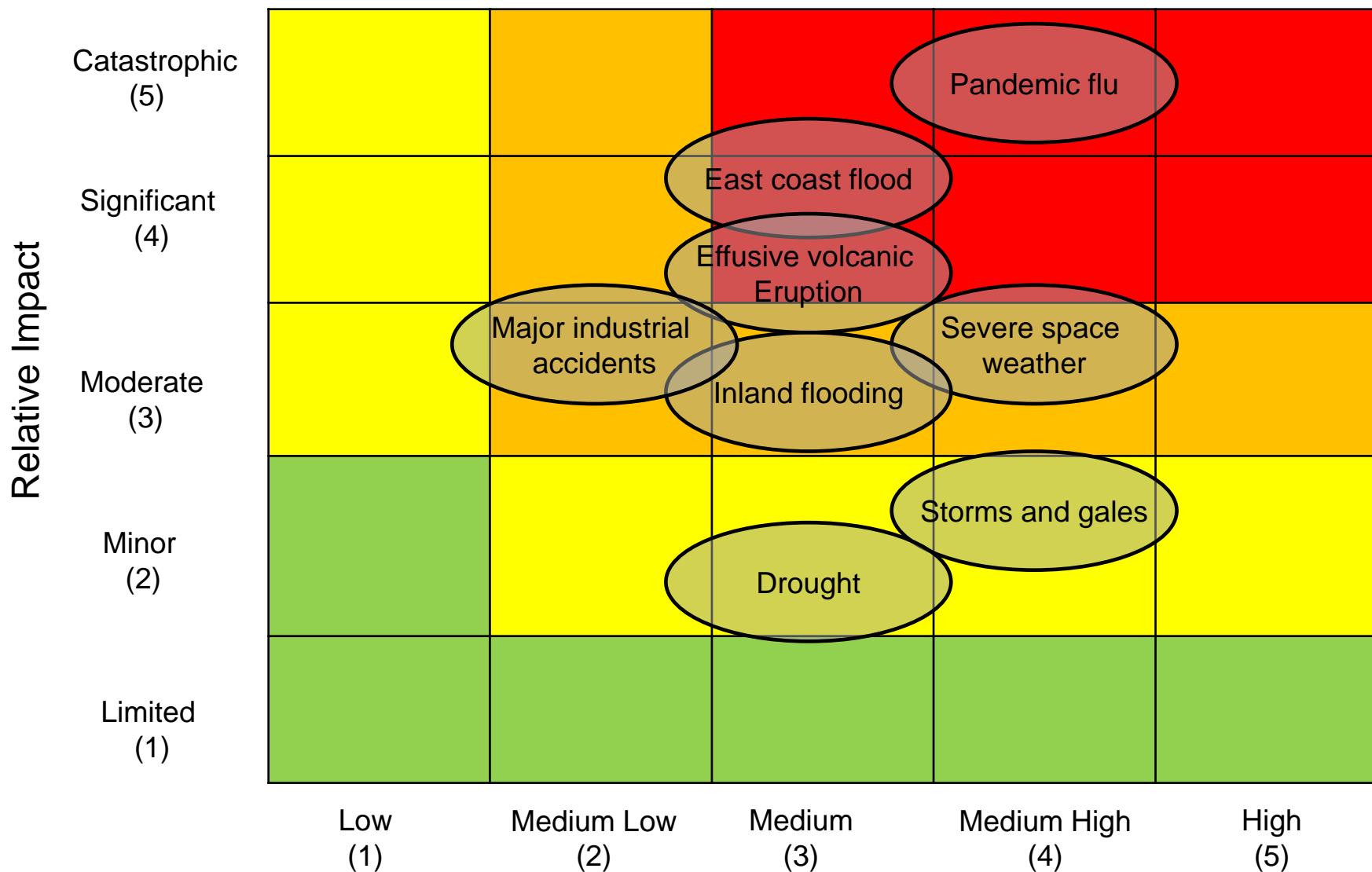
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National Risk
Register of
Civil Emergencies

2012 edition



Where does space weather fit?





UK Government's approach

- First appeared in **National Risk Assessment (NRA)** in 2011
- **Met Office** 'own' the assessment of the risk for the NRA
- **Cabinet Office** co-ordination: **Severe Space Weather Project** set up April 2013
 - Accountable to **High Impact Hazards Programme Board** - chaired by Director, Civil Contingencies (until April 2014)
 - Cabinet Office will continue to resource a 'working group'
- **SEIEG** provides expert advice to the project - chaired by Prof Mike Hapgood (RAL Space)
- **International collaboration** (US, Sweden, Canada, EU, NATO) critical
- Main outputs: **enhanced capabilities** to be reflected in **response plans** and **preparedness strategy** for a severe space weather incident



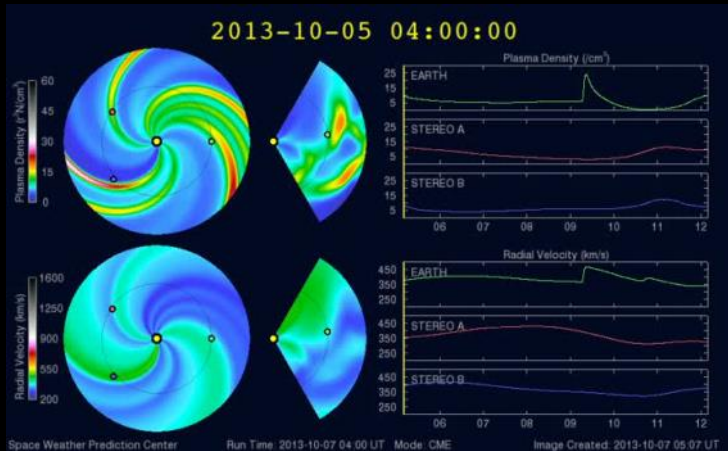
Progress over the last 12 months

- Met Office 24/7 **forecasting** capability developed
- Government **response guide** drafted and **gap analysis** of resilience and response capabilities produced
- Work with National Grid to increase resilience of **power grid** continued
- Workshop of **aviation response** - Civil Aviation Authority (CAA) and National Air Traffic Control (NATS)
- **Cosmic Radiation Advisory Group** (CRAG) developing advice on health impacts for civil aviation
- Research started on impact on **rail** network
- Advisory notices issued to **aviation** and **maritime** sectors
- Wide range of **international** engagement including NATO and JRC workshops



Met Office Space Weather Operations Centre

- Embedded in Met Office Hazard Centre
 - 24x7x365 – 29 April'14
 - Full capability autumn '14
- Collaborate with academia not replicate
- Operational collaboration with NOAA SWPC & BGS
 - Daily forecast coordination
- Add UK-centric advice and impacts



Space Weather Guidance (Ref: MO43)

For Internal distribution only

Issued on Wednesday, 02 April 2014 at 01:38 local

This guidance document provides a four day assessment of Space Weather events and is meant for internal use allowing teams to provide advice and guidance products to external stakeholders and customers. To be issued by 00:30 UTC, but will be updated if there are significant changes. Stated probabilities are for reaching or exceeding given levels. For more information about space weather impacts please see the NOAA Space Weather Scales <http://www.swpc.noaa.gov/NOAAScales/index.html>

Space Weather Forecast Headline: Chance of minor geomagnetic storm (G1) day 1. Chance for M-flares –radio blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar activity has been at low levels over the last 24 hours, the largest flare being a C3 at 01/0050UTC, from AR2022 in the northeast quadrant. There are currently 7 numbered active regions on the visible disc, of which AR2021 and AR2026 are most complex (beta-gamma). However, SDO imagery suggests that both are developing and growing with signs of possible delta spot development (in the intermediary spots of AR2021, and the leading group of AR2026) (Figure 1). A succession of filament eruptions were observed to lift off through the last 24 hours, in both the SE and NE quadrants between around 01/1200 and 01/1500UTC, and another from the SW quadrant around 0950UTC. A faint full halo CME was observed in SOHO Lasco C2 associated with the former event, with corroborating imagery in Stereo. However, further imagery is needed before detailed analysis can be undertaken. The solar wind, as measured at the ACE satellite, was between 400 and 450km/s much of the day, but jumped to a peak of 502km/s at around 2053UTC. Geomagnetic activity was quiet (Kp1 or 2). The total IMF (Bt) reached 7nT at 01/1336UTC, the Bz component oscillated between -5nT and +6nT. The High Energy Electron Fluence was well below the active threshold. The High Energy Proton flux was at background levels.

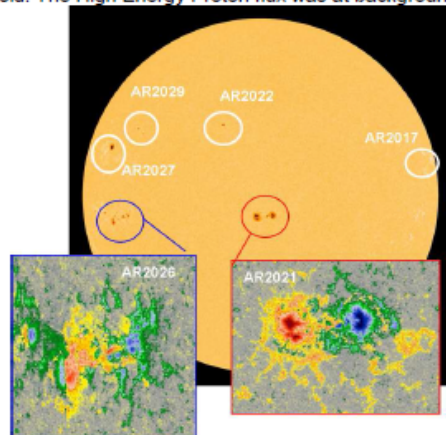


Figure 1: -
Current active sunspot regions.

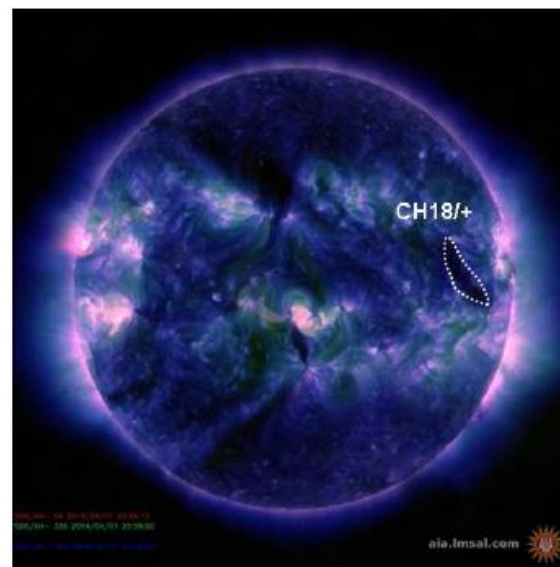


Figure 2: -
CH18, rotating into a geoeffective location. As it has +ve polarity, the associated HSS is not expected to have major impact.

Radio Blackouts - X Ray Flares:

Possible impacts upon HF Radio and Navigation on sunlit side of the Earth. In association with X-ray flares the Sun may also emit strong bursts at other wavelengths that include VHF, UHF, RADAR and GPS/GNSS frequencies. This may directly interfere with communication systems. Low Earth Orbit Satellites may also experience orbit decay.

Solar activity has low over the last 24 hours, the largest flare being a C3.4 at 01/0050UTC, from AR2022 in the northeast quadrant. C/M/X-class flare probabilities are as follows: Met Office, 95/40/5. Korean ASSA, 97/51/6. NOAA SWPC, 99/40/05 respectively. AR2021 and AR2026 are both exhibiting signs of delta spot development (using SDO imagery). Therefore, the higher probabilities from the Korean ASSA system are favoured, giving moderate solar activity with a slight chance for an X-flare.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Probability (Exceedance)						
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5



Plans for next 12 months

- ENLIL
 - Developing low res on-demand system
 - Developing small member ensemble
- European TEC using MIDAS (Bath Uni)
- Pre-operational
 - SEP forecast model (UCLan)
 - Radiation Belts model (BAS)
- Sector specific web pages (protected) & public pages
 - Defence, energy, aviation, marine, rail, satellite operators
- How to utilise step change in HPC 2015



Met Office

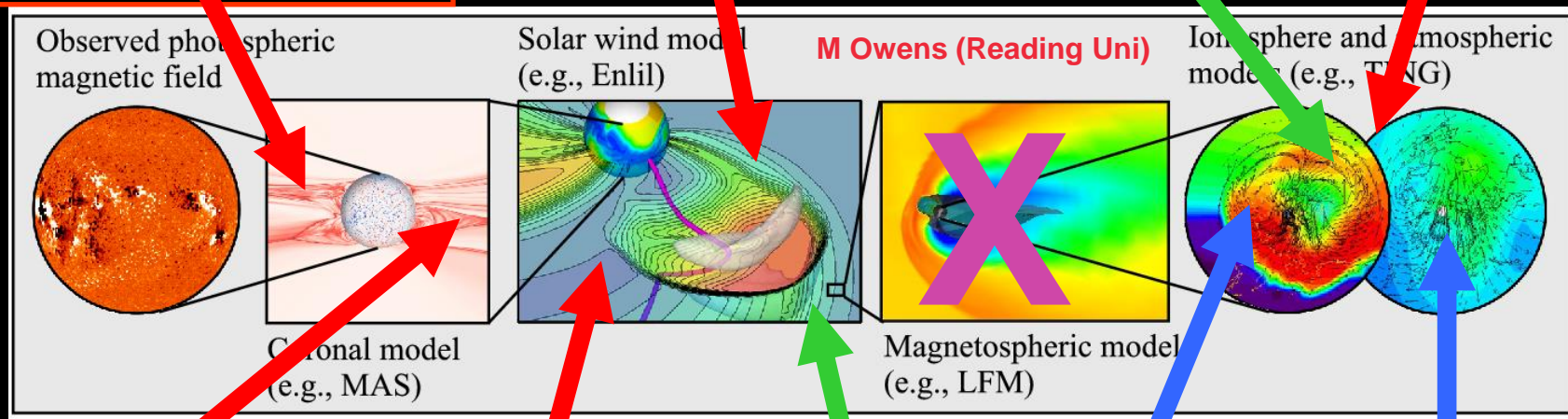
Modelling from Sun to Earth: Current R&D Status

WSA alternative - Magnetic field evolution model (Yeates & Mackay)

Improved methods of tracking solar wind features (Tucker-Hood)

Radiation belts (BAS)

Real time regional TEC (MIDAS)



WSA Enlil Ensembles

Solar wind persistence model for benchmarking / validation (Owens et al, 2013)

SEP model (S Dalla, UCLan)

Thermosphere: DA and ionosphere coupling

Whole atmosphere model plans



Next steps

- Workshop to exercise **cross-Government response** – May 2014
- Further development of
 - UK **response guide** and **preparedness strategy**
 - **rail** vulnerability assessment, including potential international workshop
- **Completion of** CRAG advice on health impacts for aviation
- Additional work with **local responders** across the UK to help them plan to respond
- Raising awareness of risk for **financial services** sector – summer 2014
- Continuing **international** engagement, especially US, Sweden etc
- **Multilateral** engagement – JRC, ESA, NATO, ICAO etc



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Questions?